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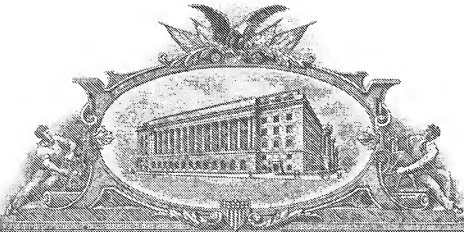
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APPLICATION NUMBER: 10/775,264

FILING DATE: February 10, 2004

RELATED PCT APPLICATION NUMBER: PCT/US05/04133



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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. 1.53(b))

Attorney Docket No.	2839.2.7
First Inventor	Eddie Caruthers, Jr.
Title	AUTONOMOUS CLEANING COMPOSITION AND METHOD
Express Mail Label No.	EV406339915US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

- ☒ Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original and a duplicate for fee processing)
- ☒ Applicant claims small entity status.
See 37 CFR 1.27.
- ☒ Specification [Total Pages **20**]
(preferred arrangement set forth below)
 - Descriptive title of the Invention
 - Cross Reference to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to sequence listing, a table, or a computer program listing appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
- ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets **0**]
- Oath or Declaration [Total Pages **2**]
 - ☒ Newly executed (original or copy)
 - ☐ Copy from a prior application (37 CFR 1.63 (d))
(for a continuation/divisional with Box 18 completed)
 - ☐ **DELETION OF INVENTOR(S)**
Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
- ☐ Application Data Sheet. See 37 CFR 1.76

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ACCOMPANYING APPLICATIONS PARTS

- ☐ Assignment Papers (cover sheet & document(s))
- ☐ 37 C.F.R. §3.73(b) Statement of Attorney (when there is an assignee)
- ☐ English Translation Document (if applicable)
- ☐ Information Disclosure Statement (IDS)/PTO-1449
- ☐ Preliminary Amendment
- ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
- ☐ Certified Copy of Priority Document(s)
(if foreign priority is claimed)
- ☐ Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
- ☒ Other: Express Mail Certificate

18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:

☐ Continuation ☐ Divisional ☒ Continuation-in-part (CIP) of prior application No. 10 / 144,331
Prior application information: Examiner Group / Art Unit:

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

19. CORRESPONDENCE ADDRESS

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Signature

E. R. Witt

Date

2/10/2004

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you are required to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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FEE TRANSMITTAL

for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT (\$) 511.00

Complete If Known

Application Number

Filing Date

First Named Inventor

Eddie Caruthers, Jr.

Examiner Name

Group / Art Unit

Attorney Docket No. 2839.2.7

METHOD OF PAYMENT (check all that apply)

☐ Check ☒ Credit card ☐ Money ☐ Other ☐ None☒ Deposit Account:

Deposit Account Number

13-0763

Deposit Account Name

Madson & Metcalf

The Commissioner is authorized to: (check all that apply)

- ☒ Charge fee(s) indicated below ☐ Credit any overpayments
☐ Charge any additional fee(s) during the pendency of this application
☐ Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code (\$)	Fee (\$)	Fee Code (\$)	Fee (\$)		
1001	770	2001	385	Utility filing fee	365.00
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	180	2005	80	Provisional filing fee	
SUBTOTAL (1)					\$ 365.00

2. EXTRA CLAIM FEES

	Total Claims	Extra Claims	Fee from below	Fee Paid
Independent Claims	34	- 20 ** = 14	X 9 =	126
Multiple Dependent Claims	2	- 3 ** = 0	X 43 =	0
			X 145 =	0

Large Entity		Small Entity		Fee Description
Fee Code (\$)	Fee (\$)	Fee Code (\$)	Fee (\$)	
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) \$ 126.00

** or number previously paid, if greater. For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code (\$)	Fee (\$)	Fee Code (\$)	Fee (\$)		
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17 (a)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) \$ 0.00

SUBMITTED BY

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Date

February 10, 2004

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CERTIFICATE OF MAILING BY "EXPRESS MAIL"

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Date of Deposit: February 10, 2004

I hereby certify that this patent application in the name of Eddie Caruthers, Jr. for AUTONOMOUS CLEANING COMPOSITION AND METHOD, together with a Declaration for Utility Patent Application, a Fee Calculation Sheet, and Credit Card Payment Form for the amounts of \$511.00 are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 on the date indicated above in an envelope addressed to Mail Stop Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Respectfully submitted,

A handwritten signature in cursive script, appearing to read "E. R. Witt", is written over a horizontal line.

Evan R. Witt
Reg. No. 32,512
Attorney for Applicant

Date: February 10, 2004

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Express Mailing Label No. EV406339915US

PATENT APPLICATION
Docket No. 2839.2.7

UNITED STATES PATENT APPLICATION

of

Eddie Lee Caruthers Jr.

for

AUTONOMOUS CLEANING COMPOSITION AND METHOD

AUTONOMOUS CLEANING COMPOSITION AND METHOD

CROSS-REFERENCED RELATED APPLICATIONS

[0001] This application is a continuation-in-part of Application No. 10/144,331, filed May 13, 2002, which is a division of Application No. 09/437,532, filed November 10, 1999, Patent No. 6,403,551. This application claims the benefit of U.S. Provisional Application No. 60/448,239, filed February 18, 2003, which applications are incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to cleaning systems, and more specifically, to compositions for cleaning with water, including slow release compositions for controlling concentrations of cleaning agents delivered into water.

[0003] Chemical cleaning agents, in one form or another, have long been used to remove dirt, oil, and particulate matter from a wide variety of articles. Cleaning improves the visual and tactile impression of an article, kills potentially harmful microbes, removes particles that interfere with breathing and vision, and may even extend the life of the article being cleaned. Things such as cookware, homes, automobiles, clothing, and the human body itself stand to benefit from the development of enhanced cleaning agents. Although the present invention contemplates cleaning systems useful for cleaning a wide variety of articles, it is particularly well-adapted for cleaning clothes, as in a washing machine.

[0004] Soaps and detergents are two of the most common cleaning agents presently used. While they are often used interchangeably, the words "soap" and "detergent" actually denote different classes of compounds.

[0005] Soaps are made by a process of saponification wherein a fatty acid reacts with a base to yield the salt of the fatty acid, *i.e.*, a soap. Soap probably has its origin in reacting animal fats, or lard, with alkaline salts, such as wood ash. Today, they are largely synthesized from animal fats and plant oils. Molecules of soap owe their cleaning capacity to their amphiphilic structure, which includes a hydrophobic portion consisting of a long hydrocarbon chain, and a hydrophilic portion composed of an ionic group at one end of the hydrocarbon chain. Because of the hydrocarbon chain, a molecule of soap is not truly soluble in water. Numerous molecules

of soap will suspend in water as micelles, or clusters of molecules with long hydrocarbon chains in the inner portions of the cluster, and ionic, water soluble ends facing the polar water.

[0006] Because these micelles form hydrophobic centers, they are able to dissolve other non-polar substances, like oils. Once the non-polar, oily dirt is dissolved within the micelles of soap, the ionic surfaces of the micelle repel each other, suspending the oil droplets and preventing them from coalescing. In this fashion, dirt and oil become trapped within the water soluble micelles, and wash away with the water.

[0007] A primary disadvantage of soaps is that they form insoluble salts (precipitates) with ions found in hard water. These salts, usually formed when Ca^{++} and Mg^{++} ions react with the carboxylate ends of soap molecules, precipitate out of solution as bathtub rings, grits, and other deposits. Water softeners that exchange Ca^{++} and Mg^{++} ions for more soluble Na^{+} ions can alleviate most of this problem.

[0008] Most laundry products and many household cleansers actually contain detergents, not soaps. A detergent is a compound with a hydrophobic hydrocarbon chain plus a sulfonate or sulfate ionic end (whereas soaps have carboxylic ends). Because detergents also have an amphiphilic structure, they also form micelles and clean in the same fashion as soaps. However, detergents have the advantage that most metal alkylsulfonates and sulfates are water-soluble. Therefore, detergents do not precipitate out of solution with metal ions found in water. As a result, detergents are not inhibited by hard water. In addition, detergents can be synthesized with continuous chain alkyl groups, which are more easily broken down, or biodegraded, into smaller organic molecules by the microorganisms in septic tanks and sewage treatment plants.

[0009] A drawback of most detergents is that they contain additives that take much longer to biodegrade. Some components containing phosphates must be treated in plants. Phosphates therefore promote algae growth, choking bodies of water and streams. Another disadvantage of detergents is that they can leave behind an undesirable residue even after thorough rinsing.

[0010] Detergents are currently used in many household appliances, such as dishwashers and washing machines. Presently, a user must measure out a dose of detergent to add to the cleaning appliance before every cleaning cycle. Conventional packaging and use of detergents creates messy clutter, consumes time, and typically results in a waste of detergent from

overdosing. In addition, most washing machines for clothing use a separate rinsing cycle in order to remove the residue. Thus, additional time, water, and heat energy are required to complete the washing process.

[0011] It would be a great advancement in the art to provide a novel cleaning system that uses a novel non-detergent composition of cleaner that leaves no residue and therefore, requires no rinsing cycle. Another improvement in the art would be to provide a cleaning agent that is completely biodegradable. Still another improvement would be if this cleaning agent were made from natural materials. It would also be a great advancement in the art to provide a new method for making a non-detergent cleaning agent. It would be another advancement in the art to provide a cleaning agent that cleans better than the detergents presently on the market. Furthermore, it would be an improvement in the art to simplify the cleaning process and ameliorate the resultant mess with improved, preferably measurement-free or automatic, dosing over many cleaning cycles.

BRIEF SUMMARY OF THE INVENTION

[0012] In accordance with the invention as embodied and broadly described herein, a cleaning composition and method are disclosed in suitable detail to enable one of ordinary skill in the art to make and use the invention. In certain embodiments, an apparatus for dispensing cleaning agents in accordance with the present invention includes a vessel for containing a quantity of cleaning composition in solid form. The vessel preferably allows spent cleaning composition to be replaced with fresh composition. The cleaning composition in solid form preferably provides controlled dissolution in contact with water such that a given quantity of solid cleaning composition may be used to provide cleaning agent for multiple wash cycles of a cleaning appliance.

[0013] In one embodiment, the cartridge comprises a novel composition of cleaning agent for cleaning, and solubility control component for controlling the equilibrium concentration of the cleaning composition in solution, further described below, and the controlled dissolution of the solid composition. A water source supplies water to the vessel such that at least a portion of the water contacts the cleaning composition. Treated water is then conveyed to a cleaning appliance such as a brush, wand, dishwasher, or washing machine for clothing.

[0014] Various vessels for containing the solid cleaning composition, receiving water, and conveying treated water to a cleaning appliance are described in U.S. Patent Nos. 6,178,987, 6,262,004, and 6,403,551, which patents are incorporated by reference.

[0015] Retrofit vessels for containing the solid cleaning composition may be utilized with the solid cleaning compositions within the scope of the present invention. Such retrofit vessels are designed to contain a replaceable quantity of the cleaning composition, to allow a quantity of water to contact the cleaning composition such that a controlled portion of the cleaning composition is dissolved in the water, and to allow the treated water to enter the cleaning appliance. The retrofit vessel does not need to be connected to the water feed lines of the cleaning appliance.

[0016] One typical retrofit vessel for use in a washing machine is designed to be located within the washing machine tub in a location where the water enters the tub. This may be just below the water spout. The vessel may be screened to facilitate water entering and draining the vessel. Typically only a portion of the feed water is diverted to flow into direct contact with the solid cleaning composition, and the remainder of the feed water flows directly into the tub, untreated. The exact amount of water that is diverted into contact with the cleaning composition may range from about 10% to 50% by volume, and more preferably, from 20% to 40% by volume of water. The apparatus may include movable structures for controlling the quantity of water that is diverted into contact with the cleaning resin. A door is provided to allow spent cleaning composition to be removed and replaced with fresh cleaning composition.

[0017] Enough cleaning solution should be delivered to the feed, to bring the cleaning composition to cleaning concentration when diluted in the washing appliance. Cleaning concentration is the amount of cleaning composition necessary to clean those items serviced by (e.g. placed within) the cleaning appliance during a wash cycle. In particular, a cleaning concentration for a washing machine is that concentration needed to clean a load of clothing. The amount of cleaning composition delivered to the feed is controlled by the amount of cleaning solution and the cleaning solution's equilibrium concentration. Therefore, the vessel should be configured to receive a predetermined amount of solution, and the solubility control in the cartridge should be configured to dissolve a predetermined equilibrium concentration of cleaning composition in the vessel.

[0018] As explained, a composition of cleaner in accordance with the present invention may include a mixture of a cleaning agent and a solubility control agent in a solid state. The composition may also comprise an additional alkalinity agent and a water softener. The principal cleaning agent is preferably a gas-releasing compound, such as sodium bicarbonate, sodium carbon, sodium percarbonate, sodium perborate monohydrate, sodium perborate tetrahydrate, and mixtures thereof. Gas-releasing compounds clean by reacting with acids (soils) and by mechanical microscrubbing as they yield carbon dioxide.

[0019] The solubility control agent is preferably a material resistant to dissolving in water after a designated curing time, such as potassium silicate. These compounds control solubility by dissolving only an allocated equilibrium concentration of composition in solution. The solubility control agent is preferably a material resistant to dissolving in water, i.e., water insoluble or slightly water-soluble. Such compounds control solubility by dissolving only an equilibrium concentration of composition in solution. Numerous compounds may serve this function, including but not limited to hydrophobic compounds. Those solubility control agents that are both found in nature and biodegradable are preferred.

[0020] The alkalinity agent is preferably a basic compound found in nature, such as sodium carbonate or sodium sesquicarbonate (which actually contains sodium bicarbonate and sodium carbonate in a substantially 1:1 ratio). It will be appreciated that some ingredients, such as sodium carbonate may function as both an alkalinity agent and as a gas-releasing agent. The alkalinity agent prevents the cleaning agent from releasing carbon dioxide too quickly by increasing the pH of the solution. The water softener is preferably a naturally occurring material capable of solvating hard water ions, such as a zeolite. Naturally occurring zeolites are presently preferred; however, the invention may be used with synthetic zeolites which function in a manner equivalent to natural zeolites and which biodegrade. The water softener solvates hard ions and inhibits them from reacting with other components to form insoluble salts.

[0021] The composition of cleaner may be formulated and cured into various solid shapes. One presently preferred shape is a cylindrical cartridge with an annular cross section. The annular shaped cylinder provides a useful advantage in that, as it dissolves, it retains approximately the same surface area, and hence approximately the same dissolution rate. This is because the annular shape yields an interior surface that increases in area at approximately

the same rate that the exterior surface decreases in area. Other solid shapes having a hollow interior surface may be used to provide an approximately constant dissolution rate. Such solid shapes may include, but are not limited to, oblong, oval or egg-shaped cylindrical cartridges with an annular, or similar shaped, hollow cross section and polygonal (triangular, rectangular, pentagonal, hexagonal, etc.) prisms with hollow polygonal cross sections.

[0022] The amount of solubility control component in the composition determines the equilibrium concentration of the composition in a solution, e.g., water. Therefore, the amount of solubility control component should be sufficient to yield a predetermined equilibrium concentration of composition. Similarly, the amount of cleaning agent should be sufficient to provide a predetermined amount of gas in solution. The amount of alkalinity agent should be sufficient to provide a predetermined pH in solution. The amount of water softener should be sufficient to soften household water in solution.

[0023] U.S. Patent Nos. 6,178,987, 6,262,004, and 6,403,551 disclose a solid cleaning composition containing amorphous silica as the solubility control agent. Amorphous silica (H_2SiO_3) is a preferred solubility control agent because it occurs in nature and is completely biodegradable. In the cleaning compositions containing amorphous silica disclosed in the above-identified patents, careful heating and pressurizing is needed to prepare the cleaning compositions. It has been found that commercially available potassium silicate ($\text{K}_2\text{O} \cdot n\text{SiO}_2 \cdot m\text{H}_2\text{O}$), in liquid form, may be used to prepare the cleaning compositions at room temperature without special heating or pressure. The other ingredients at approximately the same concentration may be used. Completion of the process may include casting or molding the composition in a shape selected to control surface area, and curing the composition. The composition cures independently at room temperature as water becomes depleted through evaporation and/or as a result of the anhydrous compounds absorbing water.

[0024] In certain embodiments within the scope of the present invention, the method of preparing the cleaning composition may include providing a solvent, such as water; providing a gas-releasing agent, such as sodium bicarbonate, sodium carbon, sodium percarbonate, sodium perborate monohydrate, sodium tetrahydrate, and mixtures thereof; providing a water softener, such as a zeolite; providing a solubility control agent, such as potassium silicate; mixing the

ingredients; pouring the mixture into a curing vessel; and allowing the composition to cure to a solid form.

[0025] These and other features, and advantages of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

DETAILED DESCRIPTION OF THE INVENTION

[0026] The present invention is drawn to solid cleaning compositions, methods of manufacture and use. The cleaning composition in solid form preferably provides controlled dissolution in contact with water such that a given quantity of cleaning composition may provide sufficient cleaning agent for multiple wash cycles of a cleaning appliance.

[0027] The cleaning composition may include a gas-releasing agent that is water soluble, and a solubility control agent that is only slightly water soluble. The gas-releasing agent provides cleaning action. However, if the gas-releasing agent is permitted to freely dissolve, the resulting cleaning solution will have an unknown or uncontrolled concentration of gas-releasing agent. Thus, it is desirable to add a solubility control agent to the cleaning composition to control its equilibrium concentration, and hence, the concentration of gas-releasing agent in the cleaning solution.

[0028] The cleaning composition may be further enhanced through the addition of an alkalinity agent and a water softener. The alkalinity agent controls the pH of the cleaning composition, and therefore the pH of the resultant cleaning solution. The pH of the cleaning solution should remain within a certain range because the pH controls the rate at which the gas-releasing agent reacts. The gas-releasing agent or the solubility control agent may be configured to control the pH of the cleaning solution, but a separate alkalinity agent is presently preferred. The softener prevents the formation of a residue on the items to be cleaned by solvating hard water ions. The gas-releasing agent, the solubility control agent, or the alkalinity agent may be configured to solvate hard water ions, but a separate softener is preferable.

[0029] The gas-releasing agent should not release gas in the solid state cleaning composition, but it should be able to release gas in a cleaning solution of the cleaning composition at ambient temperature. The gas-releasing agent need not react with other agents,

but may simply decompose at ambient temperature to release gas. Those gas-releasing compounds that are natural and biodegradable are preferred. In some embodiments, the gas-releasing agent is a carbonate, bicarbonate, or percarbonate. For example, sodium percarbonate, which is also known as sodium carbonate peroxyhydrate, ($2\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}_2$), sodium bicarbonate, (NaHCO_3), sodium perborate monohydrate ($\text{NaBO}_3 \cdot \text{H}_2\text{O}$), sodium perborate tetrahydrate ($\text{NaBO}_3 \cdot 4\text{H}_2\text{O}$), and sodium carbonate (Na_2CO_3) are effective, low cost gas-releasing agents. Mixtures of gas releasing agents may be used. However, numerous other gas-releasing agents are known to those skilled in the art, and all are within the scope of the present invention. Sodium percarbonate is a presently preferred gas releasing agent.

[0030] The solubility control agent should be either water insoluble or only slightly water soluble. Numerous compounds may serve this function, including but not limited to hydrophobic compounds. Those solubility control agents that are both found in nature and biodegradable are preferred. Potassium silicate is presently preferred because it may be used to prepare the solid cleaning compositions at room temperature.

[0031] The alkalinity agent may be selected from, but is not limited to, a group consisting of alkali hydroxide, alkali hydride, alkali oxide, alkali carbonate, alkali bicarbonate, alkali phosphate, alkali borate, alkali salt of mineral acid, alkali amine, alkaloid, alkali cyanide, alkali metal, and alkali earth metal. Other alkalinity agents that tend to increase the pH of a neutral solution are familiar to those in the art, and are within the scope of the present invention. Those alkalinity agents that are both found in nature and biodegradable are preferred. Sodium carbonate provides the dual function of an alkalinity agent and a gas releasing agent. Similarly, sodium percarbonate provides alkalinity control in addition to its gas release function.

[0032] The softener should preferably be selected to exchange soluble sodium or other ions for the insoluble calcium and magnesium ions. Those softeners that are both found in nature and biodegradable are preferred. A cleaning composition wherein the softener is natural zeolite ($\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot (\text{SiO}_2)_x \cdot (\text{H}_2\text{O})_x$) is presently preferred because it occurs in nature and is completely biodegradable. Of course, synthetic zeolites may be used provided that they perform the desired softening function and are biodegradable.

[0033] Because the cleaning composition is intended to be dissolved in an apparatus for delivering solvated cleaning agents at a particular concentration to a cleaning appliance, the

amount of each component of the cleaning composition is preferably tailored to provide a desired equilibrium concentration and dissolution rate.

[0034] The amount of gas-releasing agent in the cleaning composition determines how much gas is released in a cleaning solution of the cleaning composition formed when the cleaning composition dissolves in a solvent, e.g., water. Therefore, the gas-releasing agent in the cleaning composition should comprise an amount sufficient to release a predetermined amount of gas in a cleaning solution of the cleaning composition. A concentration of gas-releasing agent from 20% to 60% by weight of the cleaning composition is preferred. In one embodiment, the concentration of gas-releasing agent is from 35% to 45% by weight.

[0035] The amount of solubility control agent in the cleaning composition determines the equilibrium concentration of the cleaning composition in the cleaning solution. Therefore, the amount of solubility control agent in the cleaning composition should be selected to yield a predetermined equilibrium concentration of cleaning composition in the cleaning solution. A concentration of solubility control agent from 5% to 35% by weight of the cleaning composition is presently preferred. In one embodiment, the concentration of solubility control agent is about 30% by weight to yield an equilibrium concentration of the cleaning composition that is approximately 0.12% by weight in water.

[0036] The amount of alkalinity agent in the cleaning composition affects the pH of the cleaning solution. Therefore, the cleaning composition should include an amount of alkalinity agent selected to provide a cleaning solution with a predetermined pH. A concentration of alkalinity agent from 1% to 35% by weight of the cleaning composition is presently preferred. Because the alkalinity agent may also provide gas releasing functionality, in the case of sodium carbonate, the actual concentration of the gas releasing agent and alkalinity agent may be outside the foregoing concentration range. In one embodiment, the concentration of alkalinity agent is about 3 % by weight, providing a cleaning solution with a pH of about 8.8 after dilution inside the cleaning appliance.

[0037] The softener in the cleaning composition softens the cleaning solution by scavenging residue-forming ions. Therefore, the softener should comprise an amount of cleaning composition sufficient to soften household water. A concentration of softener from 1% to 20%

by weight of the cleaning composition is presently preferred. In one embodiment, the concentration of the softener is about 8% by weight.

[0038] Water molecules may form complexes with these components and could be bound up within the cleaning composition by virtue of the process of making the cleaning composition. Water may comprise from 1% to 50% of the cleaning composition by weight. Preferably, water comprises approximately 20% by weight of the cleaning composition. It will be appreciated that some components of the cleaning composition may contain water, such as potassium silicate, which may limit the amount of extra water that needs to be mixed with the dry ingredients.

[0039] In operation, items to be cleaned are exposed to the cleaning solution, which causes a number of processes occur. The basic cleaning solution attacks the acids in dirt and oil. In a first reaction step, the gas-releasing agent reacts with dirt and oil. In a gas-releasing step, gas is released. In a cleaning appliance for washing clothing, dirt and oil would be dislodged from clothing in a removal step due to reaction and the sudden release of gas. In a second reaction step, the gas-releasing agent continues to react with removed soils.

[0040] Simultaneously, in a scavenging step, the softener scavenges ions to prevent the buildup of residue on the articles to be cleaned. In addition, the alkalinity agent keeps the pH of the cleaning solution slightly basic. This serves two functions. First of all, it bridle the reaction of the gas-releasing agent so that the gas evolves at a controlled rate and the cleaning solution has time to become thoroughly intermixed with the articles to be cleaned. Second, the basic cleaning solution reacts to neutralize acids in the soils.

[0041] An exemplary cleaning process utilizing an exemplary cleaning composition will now be described. First, the sodium percarbonate and sodium carbonate attack acids within the dirt and oils. The acid-base reactions have an emulsifying affect on the dirt and oils. Particularly, sodium percarbonate (which includes sodium carbonate) reacts with acids to generate carbon dioxide in an acid and base reaction: $2\text{H}^+(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow 2\text{Na}^+(\text{aq}) + \text{H}_2\text{O} + \text{CO}_2(\text{g})$. Most oils and dirts found in clothing are slightly acidic, and so the sodium carbonate component of the percarbonate may react with these dirts and oils to produce carbon dioxide. This tiny explosion of gas, as it bubbles out of solution, dislodges the dirt from clothes

and other materials, allowing it to be washed away. The reaction yields sodium ions in solution, or the sodium salts of the oils and dirt of the reaction, water and carbon dioxide.

[0042] In this embodiment, the byproducts of the cleaning process appear in nature, so there is no need for the extensive treatment of phosphates and other non-biodegradable materials, as required by presently available detergents. However, the alkalinity agent, which may include sodium carbonate, is added primarily to increase the pH of the cleaning solution but also functions as a gas releasing agent, described above. In a similar manner, sodium percarbonate, is added primarily as a gas releasing agent but also increases the pH of the cleaning solution as an alkalinity agent.

[0043] The alkalinity agent provides a mildly basic solution to prevent the sodium percarbonate from reacting with excess hydrogen ions (H^+) in aqueous solution. Without the alkalinity agent, CO_2 would bubble out of solution too quickly as the sodium percarbonate reacts with random hydrogen ions. With a slightly alkaline cleaning solution, in one embodiment approximately 8.8 pH, the sodium percarbonate reacts at a controlled pace, and preferably with the acids in the dirt and oils.

[0044] The softener, which may be natural zeolite, exchanges sodium ions (Na^+) for magnesium (Mg^{++}) and calcium (Ca^{++}) ions: $Mg^{++} + Ca^{++} + \text{zeolite} \rightarrow \text{zeolite} + 4Na^+$. Sodium ions and sodium salts are readily water soluble and will not form precipitates. Without the softener, the Mg^{++} and Ca^{++} could react to form insoluble salts, precipitating out of solution and leaving a hard film behind, as shown by the following equations: $NaHCO_3 + Mg^{++} \rightarrow MgCO_3$, and $NaHCO_3 + Ca^{++} \rightarrow CaCO_3$.

[0045] One possible method for making the cleaning composition in a solid state will be described. In the described method a solvent, a gas releasing agent, a solubility control agent, an alkalinity agent, and a softener, are combined to form the cleaning composition. It will be appreciated that the cleaning composition may be manufactured with some components performing multiple functions or with additional, unnamed agents.

[0046] The solvent may be included with the solubility control agent, if in liquid form. The solvent will typically be water, and may comprise from 1% to 50% by weight of the cleaning composition. The concentration of the other foregoing ingredients may be generally identified as follows: gas-releasing agent, 20% to 60% by weight of the cleaning composition; water

softener, 1% to 20% by weight of the cleaning composition; solubility control agent, 5% to 35% by weight of the cleaning composition; and alkalinity agent, 1% to 35% by weight of the cleaning composition. More preferably, the concentration of the foregoing ingredients may be generally identified as follows: gas-releasing agent, 30% to 45% by weight of the cleaning composition; water softener, 5% to 15% by weight of the cleaning composition; solubility control agent, 20% to 35% by weight of the cleaning composition; and alkalinity agent, 20% to 35% by weight of the cleaning composition.

[0047] One cleaning composition within the scope of the invention has the following ingredients set forth in Table 1:

[0048]

Table 1

<u>Ingredient</u>	<u>Weight Percent</u>
Water	29%
Sodium Bicarbonate	39%
Natural Zeolite	8%
Potassium silicate	21%
Sodium Sesquicarbonate	3%

[0049] Another cleaning composition within the scope of the present invention has the following ingredients set forth in Table 2:

[0050]

Table 2

<u>Ingredient</u>	<u>Weight Percent</u>
Sodium Perborate	
Monohydrate	37.0%
Sodium Carbonate	31.2%
Natural Zeolite	8%
Optical Brightener	1.0%
Potassium silicate	22.8%

[0051] With the formula of Table 2, ingredients were added as listed. The powders (first four items) were combined and mixed prior to adding liquid potassium silicate. After adding

the potassium silicate, the product was mixed briefly and poured into a mold. Set-up and hardening began within ten minutes after the addition of the potassium silicate at room temperature.

[0052] The optical brightener is an additive that improves visual appearance in cleaned fabrics. An optical brightener may be added to the cleaning composition in an amount from about 1% to 3% by weight. The sodium perborate monohydrate and the sodium carbonate both release gas. The carbonate releases carbon dioxide and the perborate releases oxygen. The potassium silicate provides some solubility control. The sodium carbonate serves a dual role as gas releaser and alkalinity agent.

[0053] It has been found that potassium silicate may be used successfully, while sodium silicate may not be used to prepare the cleaning composition. While not being bound by theory, it is believed that potassium silicate is operative because it does not raise the pH too high. Potassium silicate has a pH of about 11, whereas sodium silicate has a pH of about 13. With this information, it may be possible to include a suitable pH modifier with sodium silicate to successfully prepare the cleaning composition.

[0054] Yet another cleaning composition within the scope of the present invention has the following ingredients set forth in Table 3:

[0055] Table 3

<u>Ingredient</u>	<u>Weight Percent</u>
Sodium Percarbonate	38%
Sodium Carbonate	25%
Carboxymethylcellulose	1%
Natural Zeolite	8%
Potassium silicate	28%

[0056] With the formula of Table 3, ingredients were added as listed. The powders (first four items) were combined and slowly mixed to minimize dusting, but mixed brisk enough to ensure total dispersion. The liquid potassium silicate was added slowing with the mixer running. As the product thickens, a small amount of base (sodium hydroxide, less than 0.5 weight percent) was added to aid in processing by thinning the material and allowing a longer

mix time. After about 5 to 10 minutes, the product started to stiffen, and it was poured into a mold for curing. Set-up and hardening began within ten minutes after the addition of the potassium silicate at room temperature.

[0057] The carboxymethylcellulose is a soil anti-redeposition compound. The sodium percarbonate and the sodium carbonate both release gas. The carbonate releases carbon dioxide and the percarbonate releases oxygen. The potassium silicate provides some solubility control. The sodium carbonate serves a dual role as gas releaser and alkalinity agent. The amounts listed in Table 3 can be varied by a few weight percent.

[0058] The present invention may be embodied in other specific forms without departing from its structures, methods, or other essential characteristics as broadly described herein and claimed hereinafter. The described embodiments are to be considered in all respects only as illustrative, and not restrictive. The scope of the invention is, therefore, indicated by the appended claims, rather than by the foregoing description. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

CLAIMS:

1. A cleaning composition in a solid state comprising:
 - a gas-releasing component as a cleaning agent selected from the group consisting of carbonates, bicarbonates, perborates, percarbonates, and mixtures thereof, wherein the gas-releasing component is present in an amount from 20% to 60% by weight;
 - potassium silicate as a solubility control component to limit the solubility of the cleaning composition, wherein the potassium silicate is present in an amount from 5% to 35% by weight;
 - an alkalinity agent as a pH regulator, wherein the alkalinity agent is present in an amount from 1% to 35% by weight; and
 - a water softener to solvate metal ions in a solution of water, wherein the water softener is present in an amount from 1% to 20% by weight.
2. The composition of claim 1, wherein the water softener is selected from the group consisting of ion exchange particles and salts of weak acids.
3. The composition of claim 1, wherein the water softener is natural zeolite.
4. The composition of claim 1, wherein the water softener is present in an amount sufficient to soften household water after the composition reaches an equilibrium concentration in a vessel, and the equilibrium concentration is diluted in a cleaning appliance.
5. The composition in claim 1, wherein the gas-releasing component is sodium percarbonate.
6. The composition in claim 1, wherein the gas-releasing component is sodium bicarbonate.
7. The composition in claim 1, wherein the gas-releasing component is sodium carbonate.

8. The composition in claim 1, wherein the gas-releasing component is present in an amount sufficient to release an effective amount of gas after the composition reaches an equilibrium concentration in a vessel, and the equilibrium concentration is diluted in a cleaning appliance.

9. The composition in claim 8, wherein the effective amount of gas generated is from about 5% to about 9.5% by volume with respect to the volume of water.

10. The composition of claim 1, wherein the alkalinity agent is selected from the group consisting of an alkali hydroxide, alkali hydride, alkali oxide, alkali sesquicarbonate, alkali carbonate, alkali phosphate, alkali borate, alkali salt of mineral acid, alkali amine, alkaloid, and alkali cyanide.

11. The composition of claim 1, wherein the alkalinity agent is sodium carbonate.

12. The composition of claim 1, wherein the alkalinity agent is present in an amount sufficient to give a solution of the composition a pH greater than 7.

13. The composition of claim 1, wherein the alkalinity agent is present in an amount sufficient to give a solution of the composition a pH from about 7.8 to about 8.8.

14. The composition of claim 1, further comprising an anti-redeposition component present in an amount from about 1% to 3% by weight.

15. The composition of claim 1, wherein the cleaning composition is in a solid form having a surface area configuration designed to provide approximately constant surface area as the cleaning composition dissolves.

16. A cleaning composition in a solid state comprising:
a gas-releasing component as a cleaning agent selected which is sodium percarbonate;
a solubility control component which is potassium silicate to limit the solubility of the cleaning composition;
an alkalinity agent as a pH regulator which is an alkali carbonate; and
a zeolite water softener to solvate metal ions in a solution of water.

17. The composition of claim 16, wherein the gas-releasing component is present in an amount from 20% to 60% by weight.

18. The composition of claim 16, wherein the solubility control component is present in an amount from 5% to 35% by weight.

19. The composition of claim 16, wherein the water softener is present in an amount from 1% to 20% by weight.

20. The composition of claim 16, wherein the gas-releasing component is present in an amount from 30% to 45% by weight, wherein the solubility control component is present in an amount from 20% to 35% by weight, wherein the water softener is present in an amount from 5% to 15% by weight, and wherein the alkalinity agent is present in an amount from 20% to 35% by weight.

21. The composition of claim 16, wherein the alkalinity agent is present in an amount sufficient to give a solution of the composition a pH greater than 7.

22. The composition of claim 16, wherein the alkalinity agent is present in an amount sufficient to give a solution of the composition a pH from about 7.8 to about 8.8.

23. The composition of claim 16, further comprising an anti-redeposition component present in an amount from about 1% to 3% by weight.

24. The composition of claim 16, wherein the cleaning composition is in a solid form having a surface area configuration designed to provide approximately constant surface area as the cleaning composition dissolves.

25. A method of making the cleaning composition of claim 1 comprising the steps of:

mixing the gas releasing component, the alkalinity agent, and the water softener to form a dry mixture;

adding liquid potassium silicate while continuing to mix the dry mixture;

adding a small quantity of base, as a processing aid;

pouring the mixture into a mold; and

curing the cleaning composition.

26. The method of claim 25, wherein the small quantity of base is less than 1% by weight of the cleaning composition.

27. The method of claim 25, wherein the gas releasing component is sodium percarbonate.

28. The method of claim 25, wherein the alkalinity agent is sodium carbonate.

29. The method of claim 25, wherein the water softener is a zeolite.

30. The method of claim 25, further comprising an anti-redeposition component present in an amount from about 1% to 3% by weight of the cleaning composition.

31. The method of claim 25, wherein the gas releasing component is sodium percarbonate, the alkalinity agent is sodium carbonate, and the water softener is a zeolite.

32. The method of claim 31, wherein the gas releasing component is present in an amount of about 38% by weight of the cleaning composition, wherein the alkalinity agent is present in an amount of about 25% by weight of the cleaning composition, wherein the water softener is present in an amount of about 8% by weight of the cleaning composition.

33. The method of claim 32, further comprising an anti-redeposition component present in an amount of about 1% by weight of the cleaning composition.

34. The method of claim 25, wherein the mold is configured to form a solid cleaning composition having a surface area configuration designed to provide approximately constant surface area as the cleaning composition dissolves.

ABSTRACT OF THE DISCLOSURE

[0059] A solid cleaning composition and method of manufacture are disclosed, which provide a long-term, solid cartridge made of cleaning agents and a solubility limiting agent for controlling an equilibrium concentration of the composition in a solvent, such as water. In use, the cleaning agents are dissolved only to a predetermined concentration needed for a single dose of a cleaning appliance, such as a clothes washing machine. The solid cleaning composition may be cyclically exposed to water. Controlled dissolution of the cleaning composition releases a desired quantity of cleaning agents in each cleaning cycle. The use of potassium silicate as a solubility controlling compound permits manufacture of the cleaning composition at ambient temperatures and pressures. The cleaning composition may be molded or cast into a desirable shape for controlling surface area.

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63) <input type="checkbox"/> Declaration Submitted With Initial Filing OR <input type="checkbox"/> Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)	Attorney Docket Number	2839.2.7
	First Named Inventor	Eddie L. Caruthers, Jr.
	COMPLETE IF KNOWN	
	Application Number	
	Filing Date	
	Group Art Unit	
	Examiner Name	

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

AUTONOMOUS CLEANING COMPOSITION AND METHOD

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☐ was filed on (MM/DD/YYYY) [] as United States Application Number or PCT International

Application Number [] and was amended on (MM/DD/YYYY) [] (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY) Country	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
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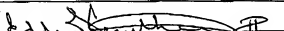
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☐ Additional inventors are being named on the _____ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.